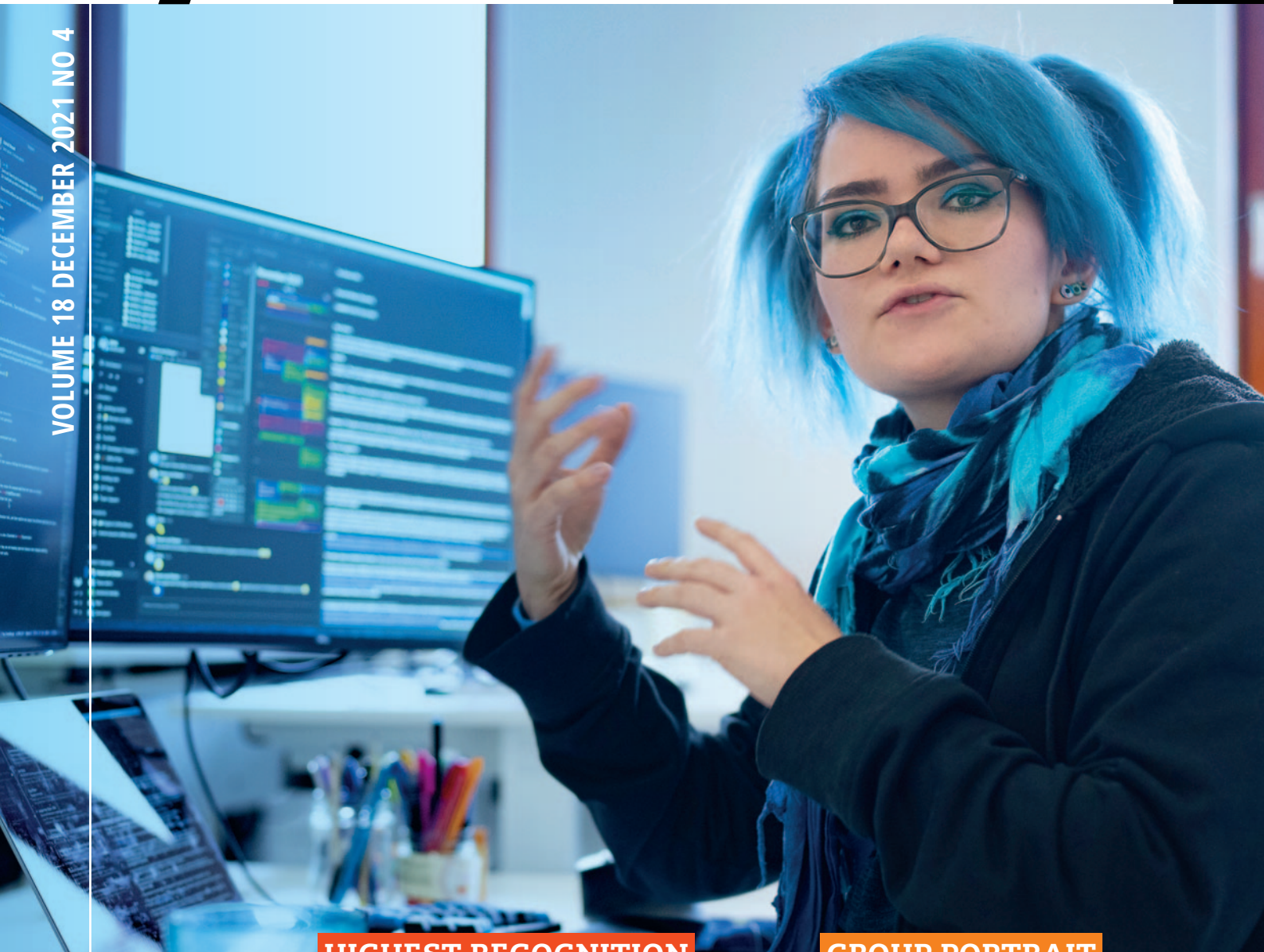


I/O magazine

ICT RESEARCH PLATFORM NEDERLAND

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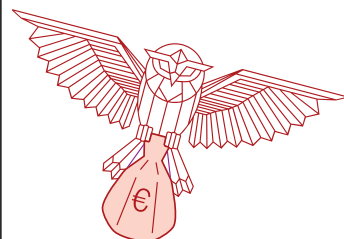
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I/O Magazine is a publication of the ICT Research Platform Nederland (IPN) and is sent free of charge to ICT researchers and relations of IPN four times a year. IPN consists of the ICT research schools ASCI, IPA, and SIKS; the ICT-related themes of NWO domains Science (ENW) and Applied and Engineering Sciences (AES); the institutes of the technical universities, united in NIRICT; the institutes of the general universities; SURF; e-Science Center; CWI; Dutch Platform for Mathematics; Data Science Platform Netherlands; Dutch Tech Center for Life Sciences; VERSEN; TNO and COMMIT.

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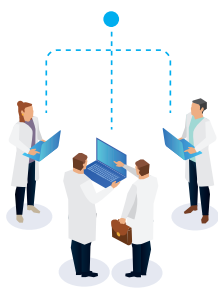
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IPN ICT-ONDERZOEK
PLATFORM
NEDERLAND

PAUL KLINT

#LeaveMetaAlone

The word 'meta' is dear to my heart. What a shock that it is now misused in Facebook's cover-up operation.

Things I hate:

1. Vandalism
2. Irony
3. Lists

This self-referential humour seen on a wall in Paris gives us a head start in discussing the word 'meta'. It is mostly used to indicate a difference in level. Meta-X describes properties of X: a meta-joke like A rabbi, a priest and an imam walk into a bar. 'What!' says the bartender, 'Is this a joke?', a meta-language that describes another language, or a meta-program that analyses or generates other programs. I am interested in meta-environments: interactive development environments to describe what interactive development environments for programming languages or domain-specific languages should look like and how these should behave. Key properties of any meta-X: abstraction and self-reference.

Neal Stephenson created the concept of a Metaverse in 1992 as a virtual reality successor of the internet in which avatars interact with each other and enable humans to escape from their dystopian life. In 2003, Second Life created a similar concept.

I omit here a long discussion on how appropriate the use of the word 'meta' in Metaverse actually is and jump to today's issue right away. After years of illegally using privacy information, after years of propagating misinformation and causing social divide and political unrest, after years of preferring profit over socially responsible behaviour, Facebook has now finally found a solution for all these problems: rename Facebook as Meta. In doing so, it joins the long list of memorable company name changes, ranging from Blackwater after convictions for massacres in Iraq to Philip Morris because cigarettes cause lung cancer.

Facebook has 2.91 billion users, which is more than the number of adherents of Christianity (2.3 billion) or Islam and Hinduism combined (1.9 + 1.12 billion). More than the inhabitants of China and India combined (1.4 + 1.38 billion). The Programmer Formerly Known As Mr. Facebook will not change his behaviour, and this renaming scam will not help. Only governments and the international community have the power to enforce a fundamental change in the behaviour of Facebook, ahum, Meta.

In the meantime, please do not touch our beloved 'meta':
#LeaveMetaAlone!



EXPOSING DEFECTS IN THE DIGITAL SOCIETY

José van Dijck and Bart Jacobs, some of this year's winners of the Spinoza Prize and the Stevin Prize, respectively, expose defects in the digital society. But they also want to design solutions, such as a social network that is privacy-friendly and does not polarise. They are going to collaborate on the creation and governance of public platforms.

By **Bennie Mols** Images iStock, NWO/Studio Oostrum

A few years ago, media scientist José van Dijck and digital security researcher Bart Jacobs jointly wrote an article on an app for privacy-friendly logging in, called IRMA (I Reveal My Attributes). Last September, they were both, independently, awarded the most important Dutch prizes for scientific research and its application: Van Dijck won the Spinoza Prize, Jacobs the Stevin Prize.



Bart Jacobs

'In Europe, we run American software on Chinese hardware. How do we turn that back?'

They both look at the digital society through different lenses: Van Dijck as a humanities scholar, Jacobs as a computer scientist. What diagnosis do they make when they put their finger on the pulse of today's digital society? 'My perspective is first of all security', says Jacobs, 'and then I find the situation worrying. Earlier this year, a ransomware attack shut down the Colonial Oil Pipeline in the US for days. Attacks on vital infrastructure are also realistic in the Netherlands. Cyber-attacks can jeopardise the stability of a society.'

'My concerns lie in the area of public values', says Van Dijck. 'Today's big tech companies operate globally. But all our digital systems and their embedding in institutions require us to scrutinise them through national or European legal and ethical frameworks. That gives rise to a tension. My big question is: What should Europe and, in particular, the Netherlands do to guarantee a public digital infrastructure that complies with public values such as security, privacy, transparency, sovereignty, democratic control and good governance?'



José van Dijck

'Part of the solution lies in reinvesting in public infrastructure and technical expertise for the public sector'

'Those values are currently determined too much by the developers of the technology and too little by society', Jacobs adds. 'You could say: in Europe, we run American software on Chinese hardware. Something has gone wrong there. How do we turn that back?'

Building alternatives

This double interview took place in hybrid form at a location of Utrecht University, Van Dijck's employer. Jacobs joined the interview from Nijmegen via the video platform Microsoft Teams. From a user-friendliness point of view, they both prefer the platform Zoom. However, because of privacy concerns about Zoom, Utrecht University chose Teams. 'But at the University of Amsterdam, they are allowed to use Zoom', says van Dijck. It is a perfect illustration of one of the dilemmas users and institutions face in the digital society: how do you balance convenience with fundamental values such as privacy and security?

As a matter of principle, Van Dijck and Jacobs themselves do not use Facebook, Twitter or Instagram privately. But refraining from using WhatsApp proved more difficult. Van Dijck: 'I only use WhatsApp for some family members who refuse to switch to Signal.' Jacobs used WhatsApp for a while, but switched completely to Signal: 'It suits me fine. And with some who don't use Signal, I've gone back to texting.'

That brings the conversation to building alternatives to the services of the dominant tech players. A few years ago, SURF, the collaborative organisation for IT in Dutch education and research, started hosting the video calling service on the open source platform Jitsi. 'But when the pandemic came', Jacobs says, 'we ran like crazy into the digital world. Everyone started using one of the commercial video services. However, it soon became clear that all kinds of values were not taken care of by various commercial services.'

SURF stopped supporting Jitsi at the beginning of this year. 'A pity', says Van Dijck. 'Jitsi could have been a valuable open source alternative for video calls within the public sector. It is problematic that within the public domain, we have to use commercial American systems with features or interfaces we cannot change and basic conditions we can hardly control.'

Even if we do manage to develop a successful alternative, it is not evident that the government will embrace it. Jacobs experienced this with the privacy-friendly app IRMA that he developed a few years ago. 'I have had extensive contact about IRMA with the Ministry of the Interior and Kingdom Relations', says Jacobs, 'and also with the people responsible for the governmental service DigiD. They know IRMA well. But the fundamental problem is that at the end of the day, the government treats IRMA in the same way as a company like Huawei. In fact, if the government were to treat IRMA differently from Huawei, it would be sued by private parties for distorting the market. It is difficult for the government to make sub-

stantive, value-driven choices at the moment. This is worrying. One way to make that difference is via open source requirements. That is what the Dutch Parliament is now trying to do.'

New social medium

Van Dijck and Jacobs want to put part of the prize money into developing a new kind of social medium together. The first programmer has already started at the beginning of November. They are often asked if they want to start a new Facebook. No, says Van Dijck, they do not want that at all. 'We do not want to be like Facebook. We want to start from a different understanding of what a community is and what the underlying public values should be. Why does a school have to use Facebook to let their students communicate in an online environment? We should start from the context of a community of users again, instead of having to rely on globally operating commercial platforms for everything. The starting point should be: what conditions do we want to set for social interaction in a specific context?'

What Van Dijck and Jacobs have in mind will be more like the communities you can create in WhatsApp than on Facebook, but set in a public space where transparent choices empower users. Jacobs: 'Every social platform has countless knobs you can turn. Together with José, I will investigate what is of societal importance. You can imagine that a user making a video call with her doctor has to identify herself first, but that this is not necessary for a discussion platform. There you could respond under a pseudonym. But you can build in that if someone misbehaves, the moderator can find out who is behind the pseudonym.'

Jacobs is going to put a much smaller part of the prize money into two old loves: logic and the history of cryptology. Jacobs: 'Within logic, I want to do research into probabilistic logic. That is very relevant to AI research. And a PhD student is going to do research into the use of cryptology in the Netherlands in the 20th century. There are many interesting stories to tell about that.'

For Van Dijck, eighty per cent of the prize money goes to the project 'Governing the Digital Society' that has been running for two years. 'That is an interdisciplinary project in which we, academics in media and culture, work with public administration, law and computer science. Our focus is how the public sector – schools, government, police – can integrate data flows, algorithms and platforms in their professional routines in an ethical and responsible manner. How can we regulate this? And how do we keep the digital society honest, open and transparent?'

Van Dijck emphasises that historically, the role of governments in the development of the digital society has been substantial; there have been huge public investments in the development of the computer, the inter-

net and the world wide web. 'Part of the solution to our current problems lies in reinvesting in public infrastructure and technical expertise for the public sector', Van Dijck concludes. 'If we outsource everything to Amazon, Facebook, Google and Microsoft, they will attract all the science and engineering talent, and there will be no more people in the public sector who want to build things. The public sector must also be attractive to IT professionals who want to build systems themselves.'

NWO SPINOZA PRIZE AND STEVIN PRIZE

The NWO Spinoza Prize 2021 was awarded to four researchers: José van Dijck, Professor of Media and Digital Society at Utrecht University, Marc Koper, Professor of Catalysis and Surface Chemistry at Leiden University, Lieven Vandersypen, Professor of Quantum Nanoscience at TU Delft and Maria Yazdanbakhsh, Professor in Cellular Immunology of Parasitic Infections at Leiden University. The NWO Spinoza Prize is the highest award in Dutch academia and is awarded annually to three or four researchers.

The NWO Stevin Prize 2021 went to Bart Jacobs, Professor of Security, Privacy and Identity at Radboud University and to Judi Mesman, Professor of The Interdisciplinary Study of Societal Challenges at Leiden University. The NWO Stevin Prize is intended for researchers who have achieved an exceptional success in the area of knowledge exchange and impact for society, and is awarded annually to two or three researchers.

All six laureates receive 2.5 million euros, which they can spend on scientific research and related professional activities.

More information:

www.nwo.nl/spinozapremie-2021

www.nwo.nl/nwo-stevinpremie-2021

FUND THE FOUNDATIONS

By Sonja Knols Illustration WAT ontwerpers

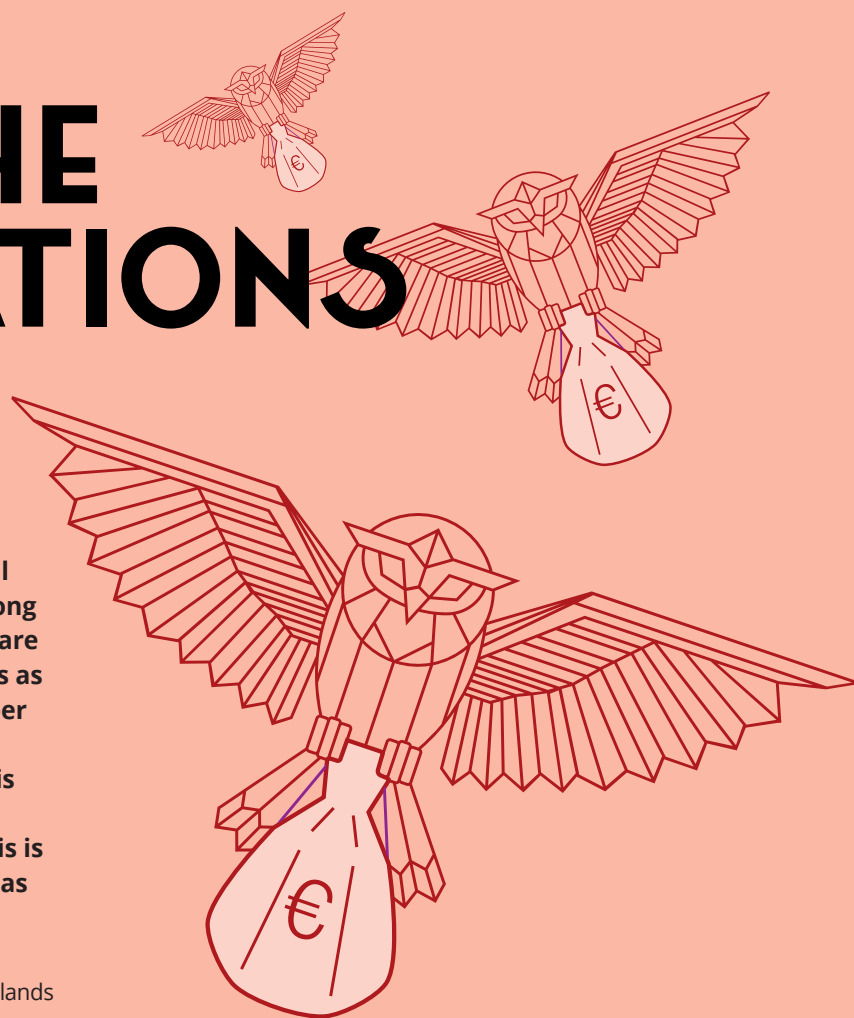
In the Netherlands, funding for fundamental ICT research has been lagging behind for a long time. On top of that, university researchers are becoming overloaded with educational tasks as a result of the immense growth in the number of computer science students. Structural funding for the foundations of ICT research is desperately needed to ensure a bright and sustainable future for our digital society. This is the main message of the IPN vision, which has recently been launched.

‘Over the past decennia, research funding in the Netherlands has increasingly shifted towards large thematic programmes of a strong application-oriented nature’, says IPN board member Andy Pimentel. ‘Of course, we are glad about the recent large investments in topics like Artificial Intelligence, but policymakers tend to overlook the importance of the more fundamental research that lies beneath these developments. They have a blind spot for more traditional ICT topics like computer systems, algorithmics and software engineering, which form the basis for future innovations.’

In fact, AI is a perfect example of this mechanism, Pimentel says. ‘If you are to develop truly reliable and trustworthy systems, you cannot just focus on the algorithms you are going to use. You have to take the entire computer stack into account, including its underlying hardware and software. It is such crucial innovations in ICT that are currently losing out in the funding circus.’

LACK OF STAFF

Besides the lack of funding for fundamental computer science, ICT researchers are also faced with another major challenge, Pimentel says. ‘In our field, the student to staff ratio is 35. In practice, this means that a lot of ICT researchers are too busy teaching to get their research done. This results in the counterintuitive mechanism that if a fundamental computer science funding scheme is opened up, relatively few applications are submitted, simply because the scientists cannot find the time to write proposals.’



Our digitalising society is screaming for IT experts. People working in industry are struggling to keep abreast of the latest developments, which highlights the need for academia to develop lifelong learning opportunities for the professional IT community. Investments in staff are desperately needed to enable the education of new ICT talent.

MAKE VOICE HEARD

The time to act is now, Pimentel concludes. ‘With this vision document, we have developed a joint plea that is backed up by the entire IPN community. We deliberately kept our message short and refer to underlying research agendas on individual computer science fields for further information on what types of questions need immediate attention.’ At the moment, IPN’s board is developing a strategy to make the computer science field’s voice heard through as many different channels as possible. ‘All help is welcome here’, Pimentel says. ‘So if you have any ideas on how to best spread the word, or who to approach at key decision making positions, please don’t hesitate to contact us!’

More information:
ict-research.nl/publications/

LONG-TERM STRATEGIC RESEARCH ON AI

Two large research consortia have been given the opportunity to further develop their research plans for the next ten years within NWO's Long-Term Programme (KIC). Their final proposals will go through the standard assessment process with referees and a selection committee, after which NWO will contribute a maximum of 40 million euros.

One of the two proposals deemed eligible for assessment is the programme ROBUST – Trustworthy AI-based systems for sustainable growth. The ROBUST consortium wants to carry out multi-year research into reliable artificial intelligence. A total of 54 partners are collaborating in this programme, 21 of whom are from knowledge institutions including 4 universities of applied sciences, 23 partners are from companies and 10 from civil society organisations. The research seeks to realise breakthroughs in five core dimensions of robust artificial intelligence: accuracy, reliability, repeatability, resilience and safety.

OTP REOPENS FOR APPLICATIONS

On 1 January 2022, the Open Technology Programme will reopen for applications. The Open Technology Programme focuses on scientific and technical research and is characterised by an absence of disciplinary boundaries. Research proposals are examined for scientific quality and from the perspective of utilisation. Both criteria are given equal weight in the decision-making process.

For each project, the NWO Domain Applied and Engineering Sciences (in Dutch: TTW) contributes a maximum of 850,000 euros. For projects with an investment character this contribution is a maximum of 1 million euros. If the total project costs are higher than 600,000 euros, a user contribution to the project costs is obligatory.

The maximum duration of projects within the Open Technology Programme is six years. You can apply continuously from 1 January 2022 to 15 December 2022 as long as the grant ceiling has not been reached.

More information:
www.nwo.nl/en/calls/open-technology-programme-2022



ICT WITH INDUSTRY 2022

From 17-21 January 2022, NWO and the Lorentz Center are organising the annual ICT with Industry workshop. During one week, about fifty researchers from Dutch universities will come together to tackle scientific challenges put forward by the participating organisations: RTL, KB, SIG, Axini and Philips.

The ICT with Industry workshop brings together scientists, in particular (junior) research staff and PhD students, and professionals from industry and government bodies. The workshop revolves around a number of case studies, which are subjected to an intense week of analysis, discussion, and modelling solutions.

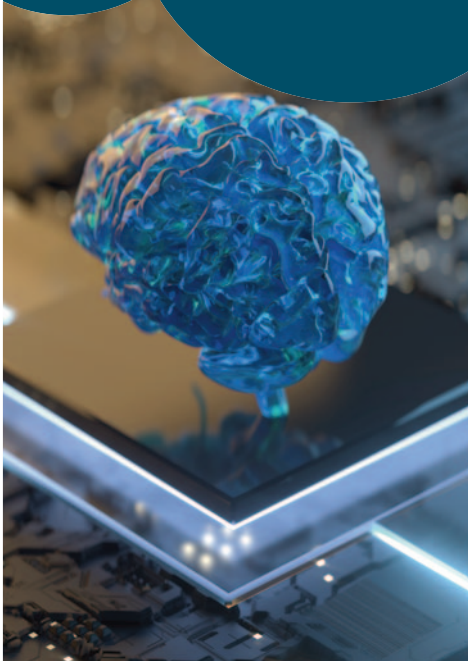
More information:
ict-research.nl/ict-with-industry



ICT.OPEN 2022

ICT.OPEN2022 will take place on 6 and 7 April 2022. This annual congress, organised by NWO and IPN, brings together fundamental ICT research and novel and innovative applications of ICT research and celebrates recent breakthroughs achieved by computer scientists in the Netherlands. More information: www.ictopen.nl

Image: Thijs ter Hart



THE TRAINING ACTOR WHO DOESN'T GET TIRED

By Leendert van der Ent
Images DialogueTrainer

At university, veterinary medicine, psychology and pharmaceutical sciences students are regularly trained in conversation skills. But how can you do that in a scalable way for larger groups? In 2013, Professor of Software technology for learning and teaching Johan Jeuring took up the challenge to design a digital solution at Utrecht University. Eight years on, the spin-off company DialogueTrainer is growing steadily and managing to attract a growing number of international customers.

As a Software Development student, Jordy van Dortmund became involved in developing the easy to use, safe and versatile online conversation simulation application Jeuring had in mind. At present, Van Dortmund and psychologist and experienced training actor Michiel Hulsbergen form the Management Team of DialogueTrainer. This is the company established in 2016 to market this activity.

CTO Van Dortmund: 'Traditionally, communications training sessions are done in role plays with training actors. These live training sessions can be very insightful for students, but come with several drawbacks. They are expensive, difficult to scale and lack uniformity across the board. Digital dialogue training brings training actors to the masses. We started out with the educational setting in mind. But we soon discovered that the benefits – such

as direct feedback, uniform scoring and scalability – are also attractive for training public servants, healthcare professionals, salespeople and call centre staff.'

LEARN FROM MISTAKES

'One of the eye-openers for us was that speaking to an avatar as a counterpart in a video response training did not form an impediment for users. The experience is very real, but it also gives them enough of a game feel to not worry about making errors', says Van Dortmund. 'Furthermore, we discovered that the digital setting gave us the opportunity to force trainees into a certain context; a well-thought-out frame that encourages them to step in all the pitfalls we lay out for them.'

'We offer all kinds of options that are not possible in a real-life situation or actual role play', Van Dortmont says. 'We can, for instance, introduce steps in the conversation, with answering options with each step, combined with direct feedback after the choice is made. Another bonus is the measurement of candidate results for reviewing performance. Organisations can store their treasured knowledge on how to converse and optimise their communication.'

If anything, DialogueTrainer's main challenge was the overwhelming number of business opportunities. Van Dortmont: There was no market, and the competition was virtually non-existent. There were only a few companies that did something remotely comparable. They focused on AR/VR technology rather than on the use case of dialogue training. This meant that Dialogue Trainer had to create the market by itself. But where to begin? Creating focus was a real challenge, but the university setting offered a good start.

'We offer all kinds of options that are not possible in a real-life situation or actual role play'



DialogueTrainer, together with Utrecht University, experiments with introducing AI. First of all, the company wants to use it for digital assessment: 'simulation as a test'. A second application is to apply 'learning analytics': analysis of scores and attained skills, an individual knowledge map. A third application can be achieved with the knowledge map: personalised content recommendation for improving specific communication skills.



Software development is becoming data-driven

By Bennie Mols Images Ivar Pel



GROUP PASSPORT

RESEARCH FIELD

Software engineering, software testing, trustworthy AI, automated software engineering, human aspects of software engineering

INSTITUTION

The Software Engineering Research Group (SERG) is part of the TU Delft Faculty of Electrical Engineering, Mathematics, and Computer Science

EMPLOYEES

(as of November 2021): 2.4 full professors, 5 tenure track assistant professors, 4 postdocs, 16 PhD students. Multiple vacancies at all levels.

WEBSITES

se.ewi.tudelft.nl

avandeursen.com

apanichella.github.io

carolin-brandt.de

GHTorrent: ghtorrent.org/

AI for Fintech: icai.ai/ai-for-fintech-lab/

The Software Engineering Research Group at TU Delft aims at improving software development from the individual programmer to teams of thousands of programmers.

Millions of software developers all over the world use the platform GitHub to learn, share and cooperate in building and maintaining open-source software. For example, GitHub is used to let multiple people make changes to web pages at the same time. When the platform started to grow rapidly, some ten years ago, Georgios Gousios from the TU Delft Software Engineering Research Group built the infrastructure GHTorrent that collects valuable data about how software is actually developed.

Group leader and Professor of Software Engineering Arie van Deursen mentions the work of Gousios as one of the recent highlights of the group he has led since 2006. 'With GHTorrent, you can see who changes which line of code, who uses a certain new feature, how the feature is used, how fast the implementation goes and who is testing what. The availability of a lot of open-source data means that we can improve software development in a data-driven way.'

Van Deursen's Software Engineering Research Group wants to improve the software development process from the small scale of the individual programmer to the large scale of millions of programmers who are active in some open source community. 'We focus a lot on software testing', says Van Deursen. 'But testing can never be complete. Therefore, we have to cleverly decide what to test and on which level. Part of the testing is done automatically, and we are constantly investigating which part of the testing can be automated and how. A recent trend is to use artificial intelligence as well.'





Annibale Panichella

Van Deursen's group does a lot of empirical research and cooperates with open source communities and companies. On 1 January 2020, they started a research partnership with the Dutch ING bank under the name 'AI for FinTech'. The research takes place under the umbrella of an ICAI Lab (Innovation Center for Artificial Intelligence), part of a national network of some 22 ICAI Labs that focus on AI technology. Van Deursen: 'ING employs 15,000 software engineers, which proves what a software-intensive company it is. Together with ING, we investigate automated program repair, incident detection and management, algorithmic bias, and data integration.'

Another theme within software development that is growing in importance is explainability, says Van Deursen: 'How do apps that are critical to society, like CoronaMelder or CoronaCheck, actually work? And why do they work that way? Explainability should be a concern from the very beginning of the software development.'

Computational intelligence

Annibale Panichella is an assistant professor in the Software Engineering Research Group. He uses AI techniques to automate the process of constructing tests, automatically find bugs in software and make automated patches to fix them. 'For this, we use techniques called "computational intelligence"', says Panichella. 'These are inspired by natural evolution and selection. We also combine these techniques with machine learning based on neural networks to speed up the search for the optimal solution and find bugs faster. We use our tool, for example, to create test cases for smart contracts, which are very popular in the blockchain community, and for testing cyber-physical systems. In the latter field, we cooperate with companies like Siemens Healthcare.'



Carolin Brandt

Panichella did a postdoc in Delft some years ago, but subsequently went to work at other universities in different countries. However, he decided to return to Delft. 'We have a very international group with some ten nationalities. It is a very open group which gives a lot of freedom to all the group members. I really like that. And it is a very strong group. Recently we were listed in the top-12 of software engineering research groups in the world.'

Interact with tools

Carolin Brandt is a PhD student who is in the second year of her NWO-funded research in the group. She is investigating how software developers can cooperate with automated test generation tools. 'Many researchers try to completely automate testing,' says Brandt, 'but I want developers to interact with automated tools. I want to use their knowledge. If you want to use AI in testing, like Annibale does, then the AI needs an objective that it can optimise. I want to know what the developer's goal is. Still, I benefit a lot from the more AI-oriented work that people like Annibale are doing.'

The group has always been very active in organising social activities, although these were, of course, limited during the corona pandemic. Before the pandemic, there was a regular barbecue, internal workshops and a Friday after hours beer tradition. Brandt: 'And members organised a reading club in which interesting papers were discussed.'

Brandt is clear about her ambition: 'I want to become a professor. When I was in Germany and considering how I could shape my academic career, several people told me independently that if I want to work in the field of software quality, the Delft group is very strong. Many of the people who have been postdocs in our group became professors later.'



Nanda Piersma holds a Master's degree in Mathematics and a PhD in Econometrics. After a period at Erasmus University Rotterdam as an assistant professor, she was employed by Amsterdam University of Applied Sciences as a programme manager and senior lecturer researcher. Piersma has been Professor of Urban Analytics seconded to CWI since September 2017 and Professor of Responsible IT since September 2020. As of 1 January 2020, she has also been the Scientific Director of the AUAS Expertise Centre for Applied Artificial Intelligence.

SHOWING HOW THINGS CAN BE DONE BETTER

‘We are beyond the phase of naming and shaming. Let’s develop alternatives for big tech companies and demonstrate how things can be done better.’ With her Responsible IT research group at Amsterdam University of Applied Sciences, Nanda Piersma is working on novel methods for the responsible development of digital technology.

By Sonja Knols

Image Ivar Pel

What does your group’s research entail?

‘In essence, our research aims to answer the question of how ICT developers can embrace more responsible ways of ICT development, with a special focus on applications in the public sector. What does an instruction like “Incorporate ethical aspects into software” actually mean for the daily practice of a developer? How can you translate required values like transparency into code? Responsible IT is only possible when developed in co-creation with users. We are trying to define a method how to do this in practice.’

Could you give an example of a situation that is hard for a developer to deal with?

‘Take recommendation systems. When you ask a programmer to make a mix between trending topics, random recommendations and personalised recommendations, what should that mix be exactly, and who determines what weighting factors to use?’

What attracts you to this topic?

‘I have always been an enthusiastic programmer myself – I am skilled in twelve programming languages and even studied Informatics for a brief period. In the early nineties, I started working on neural networks and heuristics. Back then, that was not considered to be a promising topic for mathematicians. Now Artificial Intelligence is one of the key technologies expected to shape our

future society. It is very nice to have come full circle and to be able to consider how this knowledge can now be applied in real life to genuinely benefit people.’

Besides your appointment at AUAS, over the past years, you have also been seconded to CWI. What is the added value of such a double appointment?

‘Although initially, it was quite a struggle to find the right balance, I think both institutes now form a very natural combination. I act as the linking pin between the two, determining which parts of a certain challenge fit best with whose aims and ways of working. Academic institutes and universities of applied science each have their own specific strengths and expertise. If you are able to find the right fit, you can really empower each other.’

What is your ambition for the coming years?

‘To show what can be done to come to truly responsible IT. I want to demonstrate alternatives for the big tech companies with their uniform way of working. It is time to show that it is possible to build alternatives to current clumsy services with their one size fits all mentality. After all of the naming and shaming we’ve done in the past, let’s move on to showing how things can be done better. Let’s start building software for the people instead of for the producers.’

MERGING SYMBOLIC AI WITH MACHINE LEARNING

Knowledge graphs have hugely improved web searching, automatic question-answer systems, and speech assistants like Apple's Siri. Assistant professor Jacopo Urbani tries to extend knowledge graphs with machine learning for reasoning over uncertain data.

By Bennie Mols Image iStock

When you type the search term 'Alan Turing' in Google, an information box appears to the right of the search results. The box contains the most basic information, such as who Turing was, when he was born and when he died. This kind of information is crowdsourced or automatically extracted from the web and it is stored in large graphs that Google branded as Knowledge Graphs.

Knowledge graphs are the main research focus of Jacopo Urbani, assistant professor in computer science at VU Amsterdam. He tries to merge the benefits of symbolic AI, which is based on logic, with the benefits of machine learning, essentially based on statistics. 'My research can be seen from two different points of view', says Urbani. 'From an AI perspective, I build next-generation AI using the web as a use case. From the perspective of web research, I try make the web better using AI.'

On the web, much of the knowledge is not certain. Logic-based models struggle in dealing with these uncertainties because in classical logic, everything is either true or false. 'One of the benefits of combining machine learning with logic', says Urbani, 'is that we can reason using logic, and at the same time deal with uncertainties using machine learning.'

Correct and fair

One of Urbani's favourite own research results is a reasoning machine he built for fact-checking information on the web. Urbani: 'Consider the question: "Was Barack Obama born in Kenya?" The answer is written almost nowhere, because it is considered that most people know he was born on Hawaii. But some time ago, fake news was appearing on the web that Obama was born in Kenya. Our reasoning machine was able to combine several clues and answer that search question. Moreover, unlike with machine learning, it could also explain precisely how it had arrived at its answer.'

A combination of reasoning and machine learning can also be used to make web searching fairer. Wikipedia, for example, contains more pages about the football World Cup than about a country with thirty million people like Yemen. Urbani: 'Websites like Wikipedia are often incomplete in unfair ways. Symbolic reasoning depends much less on the underlying information and so it does not inherit its biases. We can use it to make the web fairer.'

Machine learning is the branch of AI that has received most public attention over the last decade. But reasoning over knowledge graphs using symbolic AI has also become much better, basically because of improvements in the scale and quality of the graphs. 'I have the feeling that symbolic reasoning is at the same stage as machine learning just before its breakthrough', says Urbani. 'We have so many tools, algorithms and techniques. We just miss something that makes it all work perfectly together.'

More information: www.jacopourbani.it

HEALTH-RI: FAIR HEALTH DATA FOR RESEARCH AND INNOVATION

In the fragmented Dutch healthcare ecosystem, data are gathered everywhere – on various technical platforms, with the use of a wide range of templates and different numerical values. Health-RI has been awarded 69 million euros from the Growth Fund to make health data better Findable, Accessible, Interoperable and Reusable (FAIR) in a national health data infrastructure that enables improvements in healthcare with innovative digital solutions.

By Leendert van der Ent
Images WAT ontwerpers

Health-RI aims to increase the use of larger data sets in healthcare, which enable research results and innovation in the digital domain. In turn, these are key aspects for a more proactive approach to health, a paradigm shift to innovative clinical applications providing effective prevention, better diagnosis, improved treatment, and improved (cost) effectiveness.



*'There is a clear need for
a secure national health
data infrastructure'*

Hans Hofstraat, Vice President at Philips Research, which is a member of the Health-RI consortium, is clear when asked about the added value of the Health-RI initiative: 'To advance research, you need to be able to share data in large multi-party projects. There is a clear need for a secure national health data infrastructure.' That need has only increased with the growing importance of data science and AI, but progress in the Netherlands so far has been slow. Hofstraat: 'We have to catch up with front runners in implementing digital healthcare solutions such as Estonia, Finland, Denmark, the Basque region, Singapore and integrated healthcare delivery networks in the United States.' Building on several national and European research infrastructure efforts, 2015 marked the establishment of Health-RI as a community of healthcare and knowledge institutions that aims to achieve better access to data on a national level. The Netherlands Federation of University Medical Centres (NFU) committed itself to provide Health-RI a solid basis. 'Lately', says Hofstraat, 'the need for a national health data infrastructure has been widely embraced. More parties joined the initiative, with more than 70 organisations supporting the Health-RI business plan in 2017.'

Now, the national Growth Fund offers the opportunity to accelerate the gargantuan task of actually establishing that infrastructure. Wiro Niessen, Professor of Biomedical Imaging at TU Delft, Health-RI board member and one of the authors of the proposal, summarises the task ahead: 'In Health-RI we aim to make different data types accessible. For example, in the hospital setting, we often distinguish three data types: clinical data, imaging data and laboratory data such as -omics data. The FAIR principle is needed to make all these data types better usable and reusable.'

Learning system

The wish to create a learning healthcare system illustrates how Niessen became involved in Health-RI: 'In my research activities the goal is to develop AI methods that make optimal use of imaging data to support medical specialists so that both diagnosis and prognosis are improved. In this process we train the AI systems with data. In general, if more data is available, a learning system improves in terms of accuracy and robustness.'

To get more and better data, parties need to make agreements on how to collect and store data in a standardised way, using the same categories and values by following national and international standards. In that way, all data can eventually be made available for research and innovation through a single data platform. 'It is important to take the prerequisites on data collection, dissemination and use into account', says Hofstraat. 'Standardisation, agreements, appropriate laws and regulations and integration in healthcare practice and remuneration systems are crucial.'

Hub and nodes

Niessen: 'To get there, we have opted for a model comprised of a hub and regional nodes. The seven UMCs and the Eindhoven Medical Technology Innovation Center, in which Philips is one of the collaborating partners, have an important role in organising these regional nodes where the different types of data will be



stored according to agreed standards. Each node will provide information about its available data as a basis for a national catalogue to find and request data for research and innovation. We foresee use cases in which researchers receive data in a research environment or where software is sent to the regional nodes to analyse locally stored data. Both options have specific benefits and drawbacks. Whatever the approach, data integrity and privacy must be guaranteed. Best practices will lead us towards large and high-quality FAIR data sets.'

Perspective

There is currently large interest in AI, and one of Health-RI's ambitions is training AI algorithms at a large scale. That is why more 'traditional' research on large data sets can also yield huge benefits, Niessen emphasises. 'The COVID-19 pandemic has taught us how important it is to be able to quickly learn from data, for instance, to predict disease severity or to establish how effective vaccination is after a certain time period. To be able to answer these questions, you need access to data that you can compare. Comparing data is the key to transforming data into knowledge. For many people, COVID-19 was an eye-opener on how important learning from data actually is.'



'The COVID-19 pandemic has taught us how important it is to be able to quickly learn from data'

Data access in a learning system enables all types of questions and answers that can improve the healthcare system. 'It might involve diagnostics, prognostics, effectiveness of treatment and cost-effectiveness', Niessen suggests. 'Companies will also get access to better data and get more chance of successful valorisation. In the end, the national health data infrastructure will be an important factor in improving our healthcare system's sustainability.'

The sequel

'The resources to get such an infrastructure up and running are there now', Hofstraat concludes. 'The economic and health perspectives are clear. Once we get improved access to data of sufficiently large patient cohorts, it will help us develop digital solutions and implement them in clinical practice.'

Hofstraat already envisions a sequel to Health-RI, once the national health data infrastructure is in place: MedTech NL. 'The core of this programme is a uniform platform approach, building on Health-RI, including data collection, information architecture and modelling to develop, validate and implement innovations along a wide range of care trajectories. It will help us to connect

to the clinical practice in Dutch healthcare by providing digital solutions that boost the quality of care, improve the efficiency of care delivery and reduce the cost of care. And we will also be able to implement digital solutions into clinical procedures that positively impact the patient. It is our ambition to leverage experiences and proven outcomes at a global scale. Digital applications with demonstrated value will be needed to ensure access to good quality care to people wherever they are.'

HOW TO FIND FUNDS

By Sonja Knols

Obtaining grants for research is one of the major challenges computer scientists in the Netherlands face these days. Peter Bosman, Senior Researcher at Centrum Wiskunde & Informatica and Professor of Evolutionary Algorithms at TU Delft, has become well-versed in securing funding from a myriad of different sources. Here he shares some of the lessons he has learnt.

Looking back, Peter Bosman would give his past self the following advice when it comes to finding funds for his research into design and application of evolutionary algorithms: 'In line with my key research subject the simplest summary would be: adapt or die. Get out of your silo, explore the possibilities your research offers to others, and look for motivating collaborations that help you achieve your goals.'

Bigger picture

In the almost twenty years that passed since he obtained his PhD, Bosman has learnt along the way what does and does not work for him. 'When I started my academic career, I focused on writing grant proposals for fundamental research projects alone. Besides the fact that purely fundamental-oriented funds are way too scarce to begin with, I failed to strike the right chord to get my

proposals funded. Over time, I learnt that by keeping the bigger picture in mind, I could tap into a richer variety of sources of financial support.'

Looking at Bosman's current portfolio of projects it is immediately clear that his new approach paid off. Besides project funding from NWO Science, his larger research projects are also funded by NWO AES (in Dutch: TTW), the EU, KWF Dutch Cancer Society, KiKa, and something called the Gieskes-Strijbis Fund. 'That grew kind of organically', Bosman comments. 'When I started my career, I was part of a group with a focus on logistics and smart energy systems. Though these are very relevant fields, I was not intrinsically enthused by them. In a side-project, I was working with someone from Amsterdam UMC, and together we got to thinking about the possibilities my techniques could offer the medical sector. The idea that my fundamental research could ultimately help patients really motivated me, and it marked the start of my efforts to build a network in that area. As a result, almost all of my current projects are related to the life sciences sector.'

New types of funding

Through his network, Bosman became acquainted with types of funding that might not be at the top of the list for most computer scientists. 'Take the Gieskes-Strijbis Fund. I had never heard of that. But a doctor I was collaborating with was informed of this fund through one of his patients. One research direction we were considering at the time turned out to fit their goals perfectly.' That links to one of the pieces of advice that Bosman often shares with his own PhD students and postdocs:



'I learnt that by keeping the bigger picture in mind, I could tap into a richer variety of sources of financial support'

'If you are contemplating writing a proposal for a certain call, always start by reading the call text carefully. If you have to make too many modifications to make your work meet the call's intent and conditions, don't even try. The chances of your proposal getting funded will be minimal.'

Bosman stresses that he is not advocating that scientists abandon their fundamental work to obtain grants. 'It is more a matter of putting your research into a broader context. What will others be able to do with the results of your work in, say, ten years' time? The word application is not something to be scared of. The fact that you are working on something that can have an impact doesn't mean you have to fully work on that application yourself. For every grant proposal I am writing, no matter how application-oriented the call might be, I always make sure it will contain some new fundamental science element.'

Recipe

All in all, Bosman has come to this recipe that works for him: 'It all starts by developing a vision on where you want to go with your research, what is needed to get there, and what other fields or sectors could benefit from your work. Be open for collaboration, don't keep everything to yourself. Build a network of people outside your own field with whom you engage in mutually beneficial partnerships. Once you have a viable vision and meaningful partnerships, your chances of winning will have increased substantially.'

FUNDING POSSIBILITIES FOR ICT RESEARCH

NWO disburses the main part of the Dutch government's budget for academic research, and for computer science, this mainly comes from NWO AES and NWO Science. For more medical-oriented research, you can also take a look at the funding schemes of NWO's sister organisation ZonMw.

On a European level, you can turn to the Horizon 2020 programme of the European Union, the granting schemes of the European Research Council (ERC), and incidental programmes of the European Science Foundation (ESF). Furthermore, in the Netherlands, the (often less-known) private non-profit sector funds about 2.5 percent of scientific research. An overview of available funds can be found, for example, on www.fondswervingonline.nl/activiteiten/onderzoek-en-wetenschap (in Dutch).



Since 1 June 2021, Hans van Ditmarsch has been a Professor of Artificial Intelligence at the Open University of the Netherlands. Previously, he was based at the Open University of the Netherlands, University of Groningen, University of Otago, University of Aberdeen, University of Sevilla and CNRS (the University of Lorraine / LORIA). His research focuses on the dynamics of knowledge and belief, information-based security protocols, modal logics, and combinatorics.

WISER WORKFORCE

By Sonja Knols Image Bram Saeys

After having worked abroad for several decades, Hans van Ditmarsch returned to the Netherlands last summer to head a brand new Artificial intelligence group at the Open University of the Netherlands. 'We need to keep ICT professionals up to speed with the latest developments in this emerging field.'

'As a senior researcher at the Centre National de la Recherche Scientifique in France, I thoroughly enjoyed my position. But over the years I realised that I wanted to change my focus more towards education. Last year I attended the thesis defence ceremony of Josje Lodder, one of the colleagues I had worked with during my previous employment at the Open University of the Netherlands (OU) back in the 1990s. During that meeting I learnt that my former group there was planning to set up a new master's programme focussing on artificial intelligence, and that a new position would open up for a professor in that field. That was the incentive I needed to return to the Netherlands after having worked in New Zealand, Scotland, Spain and France for two decades.

The OU has a high added value that is not always respected as such. Originally set up as an institution for distance academic learning, the vast majority of our student population consists of people with a higher vocational training who have been working in industry for several years and want to deepen their knowledge in a specific field. That profile is reflected in our new, recently accredited Master in Artificial Intelligence programme, the curriculum of which is highly inspired by market demands. Though the programme is one year based on full-time study, it is primarily intended to be done as a two-year programme based on part-time study, for example on top of a daytime job.

RECOGNISED FOR RESEARCH

Besides evolving our distance learning solutions we have also become more engaged in research. In fact, the Computer Science and Information Science research unit at OU is now participating for the first time in the National Computer Science Research Assessment. AI research at our university focuses on algorithmic AI, both model-based and machine learning oriented. Personally, I have additional interests in strategic interaction and game theory.

I have been appointed for five years. It would be great if during that period we could establish a successful and feasible master's programme that trains large numbers of students. And research-wise, I aim for our work to be recognised to such an extent that we will be chosen to host the annual Benelux Artificial Intelligence Conference.'